APPLICATION FOR UNITED STATES LETTERS PATENT

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for

STORAGE CAPACITY INDICATOR FOR REMOVABLE MASS STORAGE DEVICE

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STORAGE CAPACITY INDICATOR FOR REMOVABLE MASS STORAGE DEVICE

TECHNICAL FIELD

[001] The present application relates generally to computer systems, and more specifically to removable mass storage or other types of removable devices for computer or other electronic systems.

BACKGROUND OF THE INVENTION

[002] Modern computer systems include mass storage devices such as hard drives for storing application programs to be executed by the computer system, and for storing data utilized by such programs as well as other data desired to be stored by users of the system. A hard disk is a magnetic disk on which data is stored, and the storage density of a hard disk is the amount of data that can be stored in a given area of the disk. As the storage density of hard drives has increased, meaning that more data can be stored on smaller disks, physically smaller drives having relatively large storage capacities have become possible.

[003] Physically smaller hard drives have led to removable drives, where a removable drive is a hard drive that can easily be plugged into and removed from a drive bay in the computer system. Removable hard drives make it easier to back up data and to transfer data from one computer to another, and also enable a user to more easily replace a defective drive and to upgrade software for the computer system. Furthermore, removable drives provide improved data security in many environments because a removable drive can be removed from the associated computer system and stored in a safe location when desired. Hard drives are the type of removable device being discussed herein merely for ease of description, and one skilled in the art will appreciate that the principles described herein apply equally well to other types of mass storage devices such as traditional fixed hard disks, magnetic-tape drives, CD-RW drives, and DVD-RW drives, as well as to other types of removable storage devices like USB drives.

[004] Any removable mass storage device has a finite storage capacity, and thus only a certain amount of data can be stored on the device, where the term data applies to any information stored on the removable mass storage device including program files, text files, data files, and so on. With conventional removable mass storage devices, a user of a computer system containing the drive does not know how much space is left available on the device unless he actively determines this information through seldom used commands. For example, in Windows XP Version 2002, one way a user can determine the space available on a removable mass storage device is to click <Start>, <My Computer>, right click on the desired removable mass storage device, and then select <Properties>. The <General> tab of <Properties> shows the total capacity of the device and a pie chart shows the used and free space on the device. Another approach, for those familiar with the old DOS operating system, is to click <Start>, <All Programs>, <Accessories>, <Command Prompt>, and then type the DOS command "Dir X:" where X is the letter designation assigned to the removable drive of interest.

[005] Either of these approaches requires a person to remember these esoteric commands, and also requires affirmative action by the user to obtain the desired capacity information. As a result, a user typically will not know a removable mass storage device has insufficient capacity until either the user or a program attempts to store data on the device. In this situation, the operating system displays a notice indicating there is insufficient capacity on the removable mass storage device to store the desired data. The user must at this point either delete some data from the device to make room for the desired data, or insert another removable mass storage device. While it may not be a problem to simply insert another removable mass storage device, or to add an additional device to increase the overall storage capacity of the system, a user may not have another drive available. As a result, the user may be delayed and in other ways inconvenienced when a removable mass storage device is full.

[006] There is need for a system and method of easily conveying to a user of a computer system information regarding the available storage capacity of a removable mass storage device in the system.

SUMMARY OF THE INVENTION

[007] According to one aspect of the present invention, a mass storage device, such as a removable hard disk, stores data and has an overall storage capacity. The mass storage device includes a panel on which a capacity indicator is positioned, and the capacity indicator displays either a used storage capacity or a free storage capacity of the mass storage device, or displays both free and used storage capacities of the mass storage device. The capacity indicator may be, for example, one or more light emitting diodes (LEDs), or may be an LED or liquid crystal display indicating percentage of the overall storage capacity of the mass storage device that is used, available, or both. A capacity-update program executing on a computer system of which the mass storage device is a part can update the storage capacity information being displayed, or suitable circuitry or a program within the device itself can update such information.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] **FIG. 1** is a functional block diagram of a computer system including a removable mass storage device having a capacity indicator that displays capacity information for the mass storage device according to one embodiment of the present invention.

[009] **FIG. 2** is a functional isometric view of the removable mass storage drive of **FIG. 1** showing in more detail one embodiment of the capacity indicator.

[010] **FIG. 3** is a functional isometric view of the removable mass storage drive of **FIG. 1** showing in more detail another embodiment of the capacity indicator.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[011] **FIG. 1** is a functional block diagram of a computer system ***100*** including a removable mass storage device ***102*** having a capacity indicator ***104*** that displays storage capacity information for the mass storage device according to one embodiment of the present invention. The storage capacity information displayed by the capacity indicator ***104*** allows a user of the computer system ***100*** to easily determine the used and available storage capacity of the removable mass storage device ***102***, and to take appropriate action, such as installing an additional mass storage device, responsive to the displayed storage capacity. In this way, the capacity indicator ***104*** eliminates the need for a user to remember and enter esoteric commands simply to determine the used and available storage capacity of the removable mass storage device ***102***.

[012] In the following description, certain details are set forth in conjunction with the described embodiments of the present invention to provide a sufficient understanding of the invention. One skilled in the art will appreciate, however, that the invention may be practiced without these particular details. Furthermore, one skilled in the art will appreciate that the example embodiments described below do not limit the scope of the present invention, and will also understand that various modifications, equivalents, and combinations of the disclosed embodiments are within the scope of the present invention. Finally, the operation of well known components or conventional techniques have not been shown or described in detail below to avoid unnecessarily obscuring the present invention.

[013] In the computer system ***100***, the removable mass storage drive ***102*** communicates with computer circuitry ***106*** through a suitable communications link ***108*** such as an enhanced integrated drive electronics (EIDE) interface, which is an interface standard for transferring data between computer circuitry and mass storage devices such as the removable mass storage drive ***102***, as will be understood by those skilled in the art. The removable mass storage drive ***102*** is inserted in a suitable drive bay (not shown) of the computer system ***100***, with the

drive bay providing the electrical interconnection to the computer circuitry ***106*** via the link ***108*** and physically containing the removable mass storage drive. Although only a single removable mass storage drive ***102*** is shown in **FIG. 1**, the computer system ***100*** may include multiple removable mass storage drives and associated drive bays, and may include nonremovable or "fixed" mass storage drives as well.

[014] The computer circuitry ***106*** typically includes a processor (not shown) for performing various computing functions such as running the operating system of the computer system ***100***, executing desired software or programs to perform specific tasks, and writing data to and reading data from the removable mass storage drive ***102*** via the communications link ***108***. The computer circuitry ***106*** also typically includes system memory (not shown) formed from dynamic random access memory (DRAM) and static random access memory (SRAM) that operates as a cache, with the system memory storing programs and associated data for programs currently being executed by the computer circuitry. The computer circuitry ***106*** further includes a capacity-update program or component ***110*** which executes to update the storage capacity information displayed by the capacity indicator ***104*** of the removable mass storage drive ***102***, as will be described in more detail below.

[015] The computer system ***100*** further typically includes one or more input devices ***112***, such as a keyboard or a mouse, coupled to the computer circuitry ***106*** to allow an operator to interface with the computer system. Typically, the computer system ***100*** also includes one or more output devices ***114*** coupled to the computer circuitry ***106***, such as a printer and a video terminal.

[016] In operation, the removable mass storage drive ***102*** communicates with software executing on the computer circuitry ***106*** via the link ***108***. The software executing on the computer circuitry ***102*** activates the capacity-update component ***110*** which, in turn, begins executing to update the storage capacity information displayed by the capacity indicator ***104*** on the removable mass storage drive. More specifically, as software on the computer circuitry ***106*** executes various programs, portions of the removable mass storage drive ***102*** are allocated to store data in the

form of program and data files. As the software executing on the computer circuitry ***106*** allocates portions of the removable mass storage drive ***102***, the capacity of the drive is consumed.

[017] The capacity-update component ***110*** executes to occasionally determine the used and/or available capacity of the removable mass storage drive ***102*** as the software executing on the computer circuitry ***106*** allocates portions of this drive during operation. Once the capacity-update component ***110*** determines the current used and/or available capacity of the drive ***102***, the component communicates capacity-update signals to the drive over the communications link ***108***. The capacity determined by the capacity-update component ***110*** depends on the precise storage capacity information being displayed by the capacity indicator ***104***, as will be discussed in more detail below. In response to the capacity-update signals, the removable mass storage drive ***102*** updates the storage capacity information displayed by the capacity indicator ***104***. In this way, the capacity-update component ***110*** automatically updates the storage capacity information displayed by the capacity indicator ***104***, providing a user of the computer system ***100*** with real time information regarding the storage capacity of the removal mass storage drive ***102***.

[018] The storage capacity information displayed by the capacity indicator ***104*** may vary. For example, the capacity indicator ***104*** could display utilized storage capacity as a percentage of an overall storage capacity of the removable mass storage drive ***102***. Alternatively, the capacity indicator ***104*** could display utilized storage capacity in gigabytes, or could display available storage capacity information as a percentage of overall storage capacity or in gigabytes, or could display both utilized and available storage capacities in either form. The information determined by the capacity-update component ***110*** in generating the capacity-update signals depends, of course, on the precise storage capacity information being displayed by the indicator ***104***. In other embodiments of the capacity indicator 104, the indicator may display different colors, each color representing a respective characteristic of used or available capacity on the storage

drive 102. For example, green could represent 0-50% of capacity of the drive 102, yellow 51-75%, and red 76-100%, thus letting user know at a quick glance how much capacity of the drive 102 is used and therefore how much remains.

[019] The capacity indicator 104 may have any form that provides used and/or available storage capacity information of the drive 102. For example, in another embodiment the capacity indicator 104 provides an audible indication of the capacity of the drive 102. The audible indication could be a voice occasionally stating the used and available storage capacity of the drive 102, or a voice or tone in the form of a capacity warning indicating there is only some relatively small amount--such as 10%--of the total storage capacity available on the drive 102. Thus, as used herein, the term "displays" as used with regard to capacity information includes visually and audibly providing such information, and includes other ways of providing such information as well, such as through providing a vibration. In another embodiment, the capacity indicator 104 provides capacity information even when the storage drive 102 is disconnected from the computer system 100. This provides a user with information about the remaining storage capacity of the drive 102 when, for example, the drive is sitting on a shelf and the user is selecting a drive to connect to the computer system 100.

[020] Although the capacity indicator 104 is shown as being contained in the drive 102 in the embodiments described above, this need not be the case. In other embodiments, some other component of the computer system 100 provides the capacity information and thus may be considered as containing the capacity indicator 104. For example, in another embodiment a monitor corresponding to one of output devices 114 automatically provides a graphical display of the capacity information of the drive 102. Thus, a user need not know and enter esoteric keystrokes to obtain such information, but instead is automatically provided with such information on the monitor. The precise form of such a graphical display may vary, with the display including text, graphics, or both. Moreover, the precise manner in which the graphical display is provided may also vary. For example, the graphical display could be continually provided on the monitor, or could periodically

be displayed to provide a user with capacity updates, or could require the user enter some simple keystrokes to obtain the information, such as clicking on an icon placed on a task bar or other similar portion of a monitor display.

[021] The manner in which the capacity-update component ***110*** generates the capacity-update signals may similarly vary. For example, the capacity-update component ***110*** could periodically determine the used or available capacity of the drive ***102*** and generate the corresponding capacity-update signals to update the information displayed by the indicator ***104***. Alternatively, the capacity-update component ***110*** could generate the capacity-update signals responsive to the computer circuitry ***106*** accessing the drive ***102*** to transfer data to or from. In another embodiment, the capacity-update component 110 communicates new capacity-update signals to the drive 102 only when a change in the information being displayed by the indicator 104 must be made. For example, if the indicator 104 displays used capacity in gigabytes, then only when a full additional gigabyte of capacity of the drive 102 is consumed will the component 110 provide the capacity-update signals to the drive to update the indicator 104. In this way, updates are not provided to the indicator 104 that would not result in the displayed information changing, such as fractions of gigabytes of capacity in the present example. The specific operation of the capacity-update component 110 will vary depending on the embodiment of the capacity indicator 104 being utilized. Software or hardware for forming the component 110 in these various embodiments will be understood by those skilled in the art, as will suitable circuitry or software for forming the various embodiments of the capacity indicator 104.

[022] **FIG. 2** is a functional isometric view of the removable mass storage drive ***102*** of **FIG. 1** showing in more detail one embodiment of the capacity indicator ***104***. The removable mass storage drive ***102*** includes a housing ***200*** in which electronic components (not shown) of the drive are contained, and includes a front panel ***202*** on which the capacity indicator ***104*** is positioned. In the embodiment of **FIG. 2**, the capacity indicator ***104*** is formed by a plurality of individual LEDs ***204a-g*** that collectively form a bar graph. In operation, the capacity-update component ***110***

generates the capacity-update signals to progressively illuminate the LEDs ***204a-g*** as the utilized storage capacity of the drive ***102*** increases. Thus, when only a small portion of the capacity of drive ***102*** is utilized, the LED ***204a*** is illuminated, and as more capacity is utilized the LED ***204b*** is illuminated, then the LED ***204c***, and so on until the LED ***204g*** is illuminated, indicating the drive is full or nearly full.

[023] In one embodiment, the LEDs ***204*** are different colors, with, for example, LEDs ***204a,b,c*** being green, LEDs ***204d,e*** being yellow, and LEDs ***204f,g*** being red. In this way, a user knows that when he sees a red LED ***204f,g*** illuminated, the drive ***102*** is nearly full. The storage capacity represented the LEDs ***204*** may, of course, vary. For example, the green LEDs ***204a,b,c*** could represent seventy percent of the capacity of the drive ***102***, yellow LEDs ***204d,e*** twenty percent, and LEDs ***204f,g*** ten percent. Alternatively, each LED ***204*** could represent a certain number of gigabytes.

[024] **FIG. 3** is a functional isometric view of the removable mass storage drive ***102*** of **FIG. 1** showing in more detail another embodiment of the capacity indicator ***104***. The removable mass storage drive ***102*** once again includes a housing ***300*** in which electronic components (not shown) of the drive are contained, and includes a front panel ***302*** on which the capacity indicator ***104*** is positioned. In the embodiment of **FIG. 3**, the capacity indicator ***104*** is an LCD, LED, or other suitable type of display ***304***. In operation, the capacity-update component ***110*** generates the capacity-update signals to display the desired storage capacity information on the display ***304***. In the example shown in **FIG. 3**, the display ***304*** illustrates the percentage (75%) of the drive ***102*** that is full followed by the word "FULL." Alternatively, the display ***304*** could display the capacity of the drive ***102*** that is unused or available, such as 25% where the drive is 75% full, or could display information in terms of gigabytes. The display ***304*** could also show both used and available storage capacity information. In each of these embodiments, the capacity-update component ***110*** would, of course, generate the proper capacity-update signals to properly update the information shown by the display ***304***.

[025] The removable mass storage device ***104*** may be a hard drive or other type of mass storage device. Moreover, the capacity indicator ***104*** could be included on and perform the functions described above on a variety of different types of mass storage devices, both removable and fixed, such as floppy disk drives, tape cassette drives, compact disk read-write (CD-RW) drives, digital video disk read-write (DVD-RW) drives, and USB drives. With regard to the removable mass storage drive ***104***, one skilled in the art will understand suitable circuitry for controlling the capacity indicator ***104*** to display the desired storage capacity information and to update such information responsive to the capacity-update signals. Similarly, one skilled in the art will understand suitable programming instructions or circuitry for performing the functions of the capacity-update component ***110***. In another embodiment, the capacity-update component ***110*** is contained in the removable mass storage drive ***102*** through appropriate circuitry or programming instructions, and suitable circuitry and/or programming instructions for implementing this embodiment will also be understood by those skilled in the art.

[026] Even though various embodiments of the present invention have been set forth in the foregoing description, the above disclosure is illustrative only, and changes may be made in detail and yet remain within the broad principles of the present invention. One skilled in the art will appreciate that the example embodiments described above do not limit the scope of the present invention, and will also understand various modifications, equivalents, and combinations of such embodiments are within the scope of the present invention. Therefore, the present invention is to be limited only by the appended claims.